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E02B 17/02

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(54) Assembly method for offshore platform

(57) A method of assembling an offshore platform of the kind having a generally flat shallow base 12 to rest on a seabed 24 and a relatively slender tower 14 to 17 upstanding from that base to support a deck 26 above the water surface, such method comprising the steps of installing the base and the tower by moving the base and the tower to the required site and then sinking them to the seabed so that the tower stands generally vertical, floating the deck over the top of the tower, lowering at least three spaced vertical legs 27 individually from the deck to engage the top of the tower, fixing the lower ends of the legs to the top of the tower, and then jacking the deck 26 up on the legs 27.

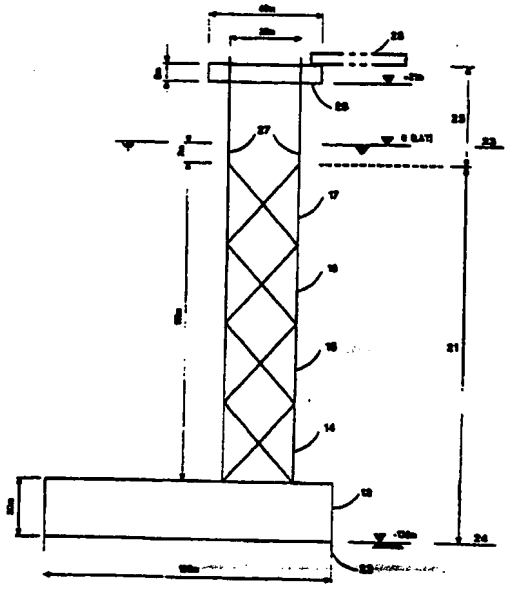

FIG 11

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FIG 1A

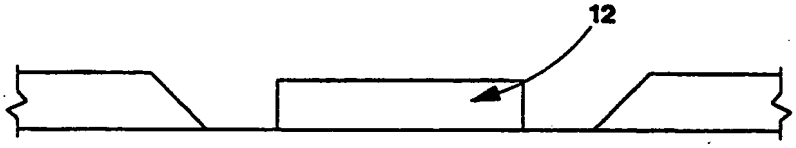


FIG 1B

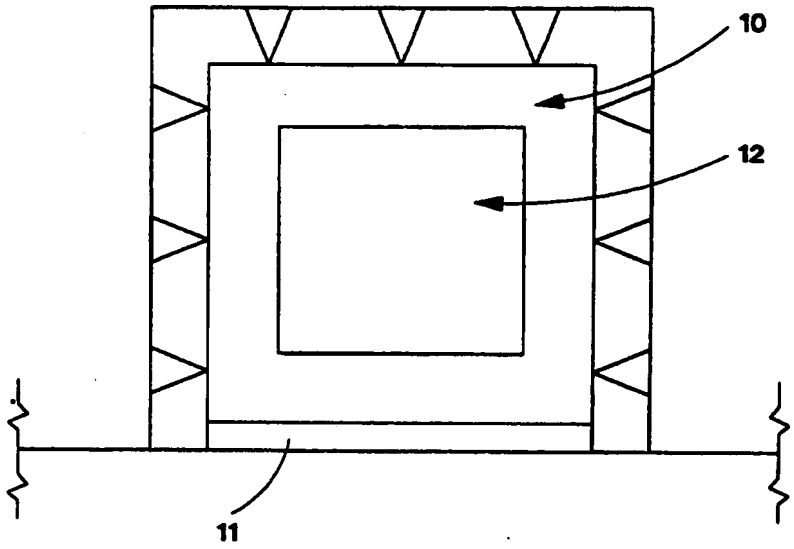


FIG 2A

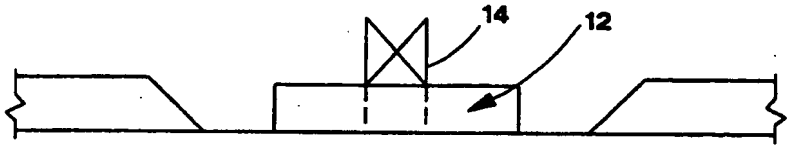


FIG 2B

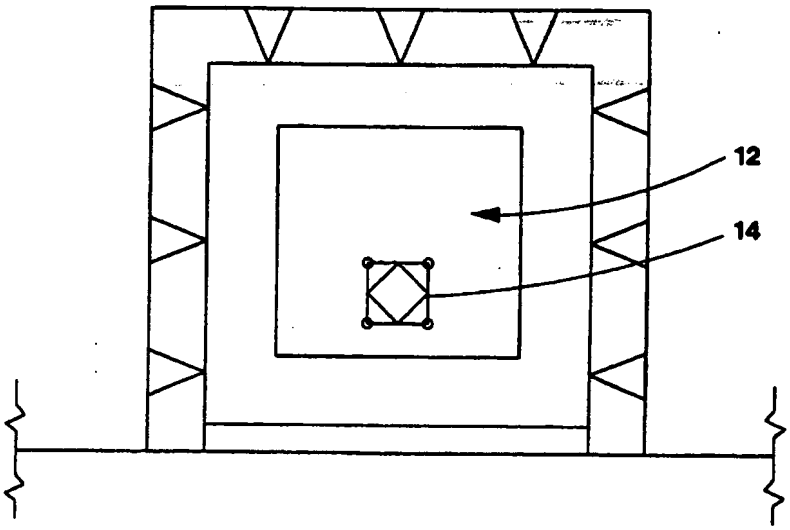


FIG 3A

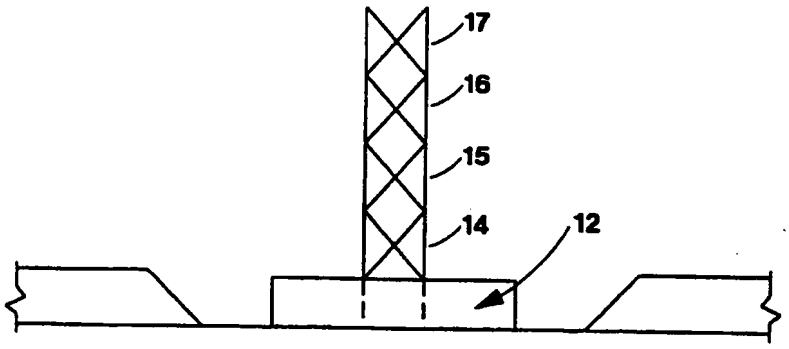


FIG 3B

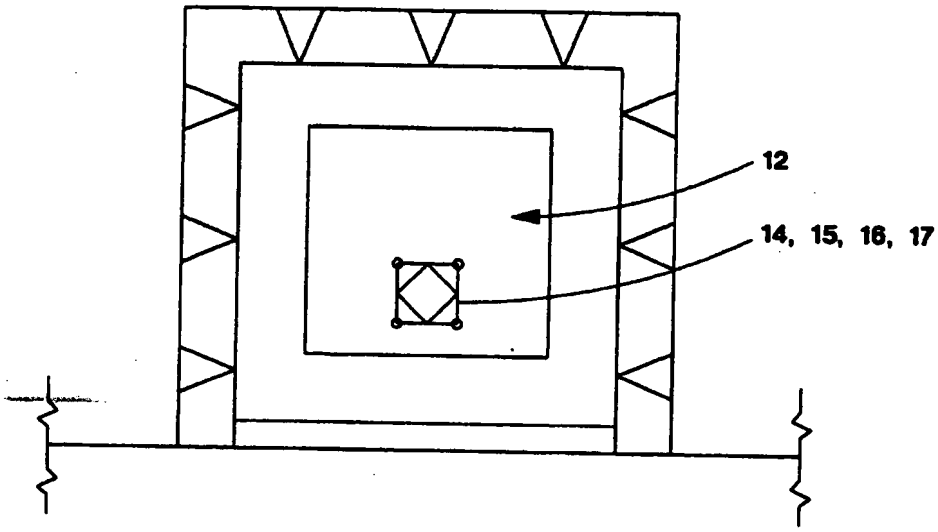


FIG 4

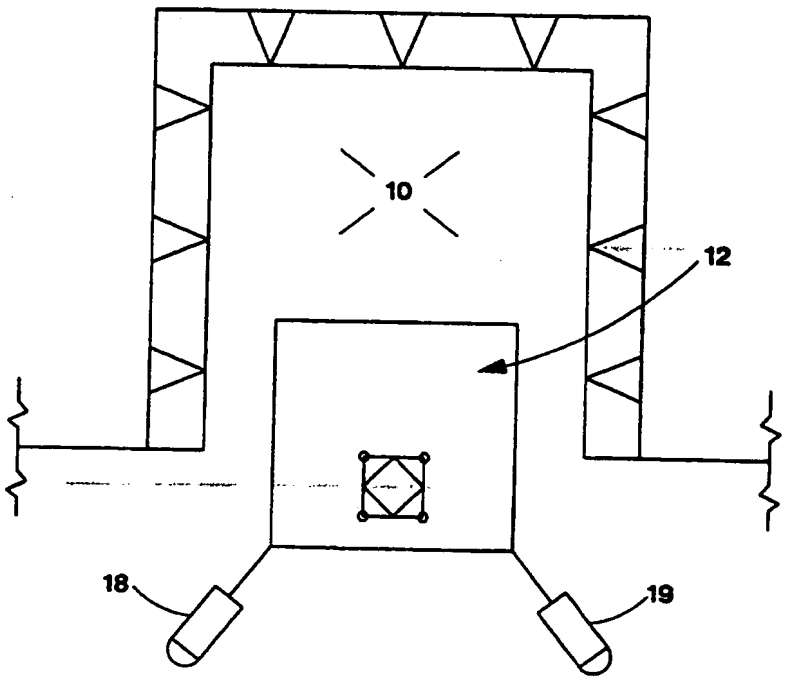


FIG 5

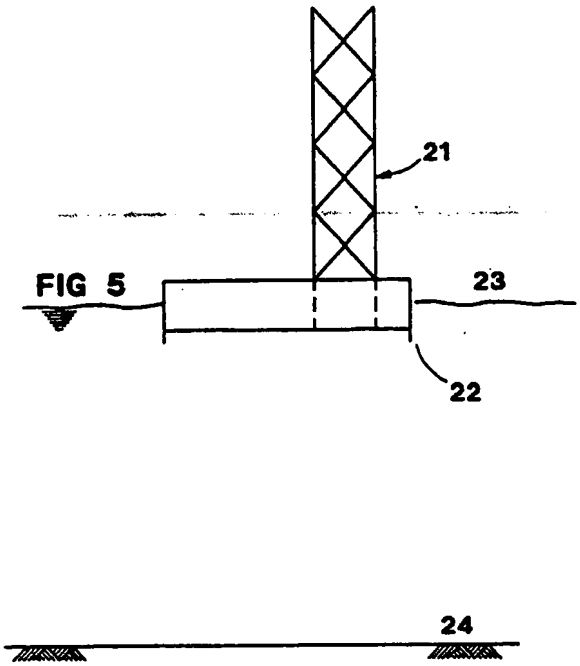


FIG 6

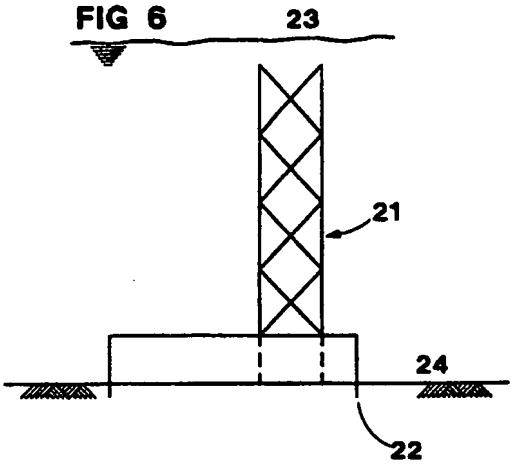


FIG 7

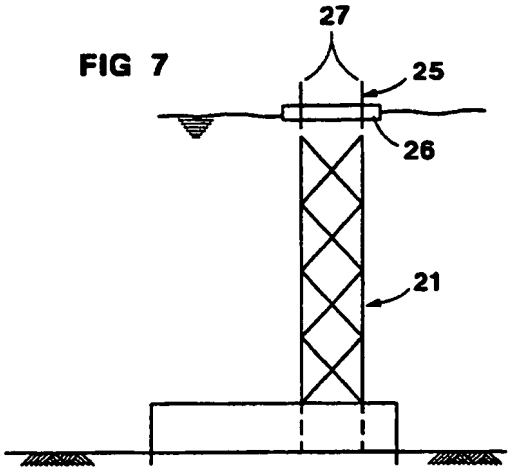


FIG 8

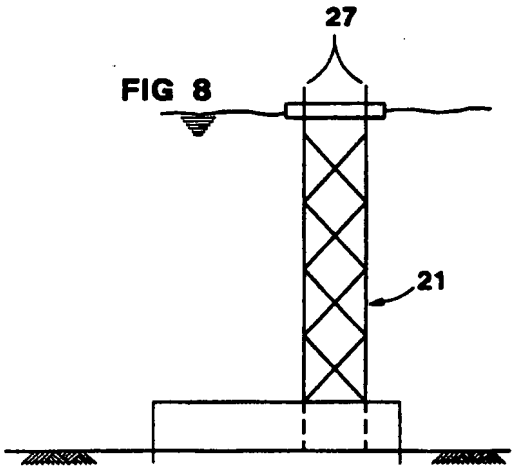


FIG 9

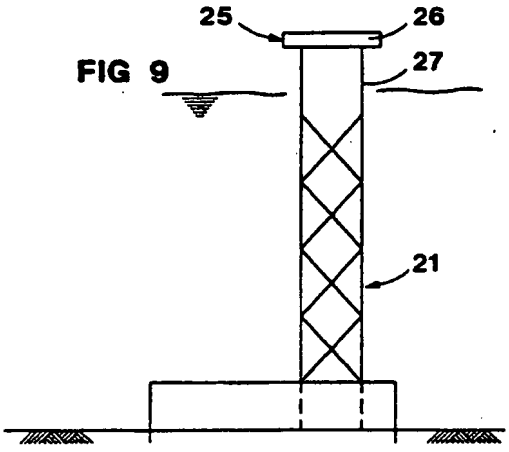
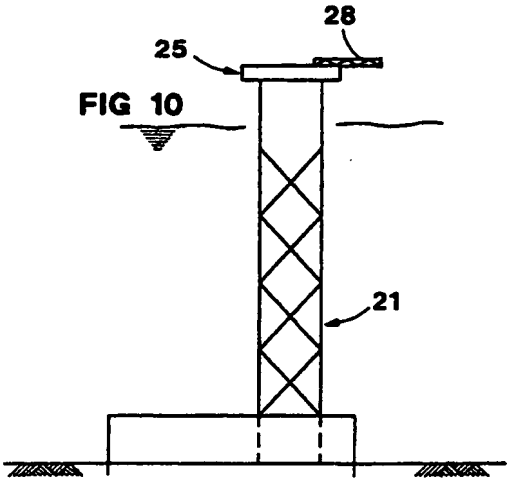


FIG 10



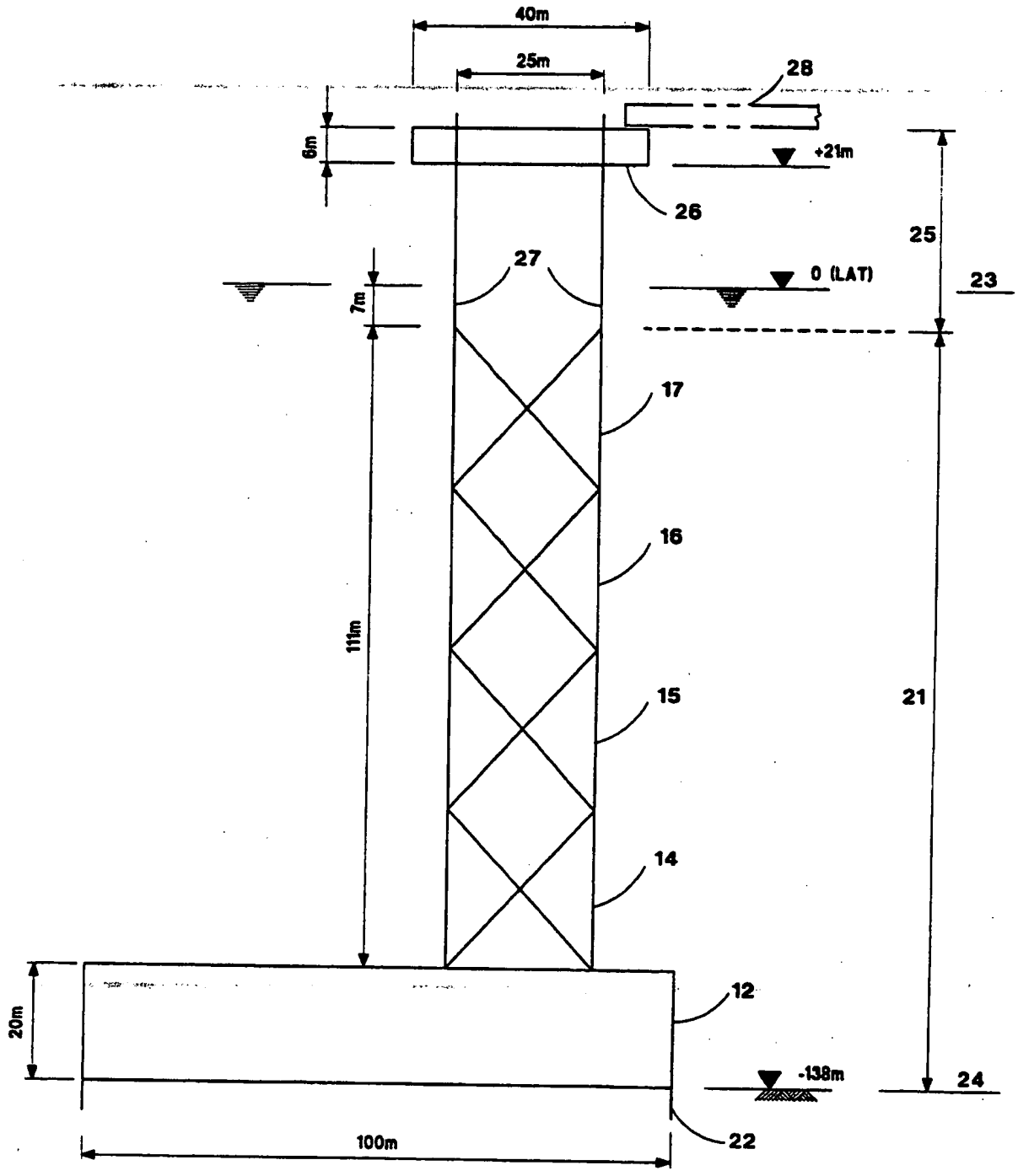

40m
25m
28
6m
+21m
26
25
27
0 (LAT)
23
7m
17
16
111m
15
21
14
12
20m
-138m
24
22
100m

FIG 11

ASSEMBLY METHOD FOR OFFSHORE PLATFORM

The invention relates to a method of assembly for an offshore platform.

Heretofore installation costs have formed a substantial part of the capital cost of offshore developments. Additionally, hook-up and commissioning activities, when carried out offshore, are much more expensive than when executed at an onshore fabrication yard. To reduce these installation and HUC costs, it has been proposed to prefabricate elements of a platform, and to assemble them offshore in a condition that requires little additional work beyond that executed in the yard.

Thus there is a requirement to construct substructures which are economical to build and install, and which can accept deck or "topside" structures in a pre-commissioned condition.

It has been proposed to build a substructure for an offshore platform in a dry dock with a gravity base, and leg elements upstanding from that base. Additionally, such a platform has had a deck constructed to rest on top of the base, with the leg elements extending up through the deck. A platform according to this proposal is illustrated in PCT Specification WO81/000423. The base and deck are independently buoyant. The platform has been floated out to its intended offshore site using the buoyancy of the base, the base has been flooded, and the base has been lowered to the seabed suspended by the legs and supported by the buoyancy of the deck. When the base has been founded on the seabed, the deck can be elevated on the legs to its final position above wave level. While this proposal allows the deck to be floated out in a pre-commissioned condition, the construction schedule is inflexible.

It has also been proposed e.g. in UK Patent Specification 1,599,631, to have a base and a deck, and several leg elements between them which may be extended successively to form a multi-tiered structure. This would allow a pre-commissioned deck to be installed as part of a platform in very deep water. However, the deck must be constructed at the same site and on top of the base, so introducing some inflexibility into the construction schedule.

The invention provides a method of assembling an offshore platform of the kind having a generally flat shallow base to rest on a seabed and a relatively slender tower upstanding from that base to support a deck above the water surface, such method comprising the steps of installing the base and the tower by moving the base and the tower to the site and then sinking them to the seabed so that the tower stands generally vertical, floating the deck over the top of the tower, lowering at least three spaced vertical legs individually from the deck to engage the top of the tower, fixing the lower ends of the legs to the top of the tower, and then jacking the deck up on the legs.

In one form the base and the tower are preassembled i.e. joined on shore or at shore before they are moved to the site.

In an alternative form the base and the tower are joined offshore prior to the float over of the deck.

In either form the tower may be formed from a plurality of tower components stacked one on top of another.

It is preferred that the base is formed of concrete.

It is also preferred that the base has provision for oil storage.

The concrete base may be formed in a floodable area (dry dock) from which the base can be towed out to site.

In this case it is preferred that the tower is constructed on the base while the base is being formed in the floodable area.

The tower may be constructed offset from the geometric centre of the base in plan.

The invention includes a platform when constructed according to the method(s) described above.

A specific embodiment of the invention will now be described by way of example with reference to the accompanying drawings, in which:

Figures 1a and 1b are a diagrammatic section and a plan respectively of the construction in a dry dock of a base for a substructure of an offshore platform;

Figures 2a and 2b show another stage in the construction of the substructure;

Figures 3a and 3b show a further stage in the construction of the substructure;

Figure 4 is a plan showing the substructure being towed out of the dock;

Figures 5 to 10 are diagrammatic side elevations showing six stages in the installation and completion of the offshore platform; and

Figure 11 is a side elevation in outline of the completed offshore platform.

The specific embodiment of this invention is concerned with a method of assembly for an offshore platform which is to stand in a water depth of about 140m in the North Sea.

The platform is to carry a relatively light topside load (in North Sea terms). It is to be located adjacent to and bridge linked with an existing offshore facility. Although the platform is to carry a light topside load, it is also required to provide buffer storage for produced oil, so that oil can be held at the field between visits by shuttle tankers to carry away the oil.

Figures 1a and 1b show an initial stage in the construction of a substructure for the platform. A dry dock 10 has been excavated at a sea shore site, and is separated from the open sea by a dock wall or bund 11. The dock wall enables construction work to be carried out using conventional civil engineering techniques on the floor of the dry dock.

At this stage a base 12 for the substructure is being formed of cast reinforced concrete on the dock floor. The base 12 is made of cellular compartments (in the manner of the base section of a 'Condeep' type structure), and some of the compartments are formed as tanks which are adapted for the storage of oil. Pipework for the input or draw off of oil is cast into the base during this stage. Provision for peripheral skirts may also be built into the edges of the base at this stage. (Examples of peripheral skirts are shown in Figure 11.)

Figures 2a and 2b show another stage in the construction of the substructure. A tower joint zone has been completed on the top of the base, and a tower portion 14 has been emplaced on that joint zone. Because of the particular function that the completed platform is to fulfil, the tower portion 14 is offset from the centre of the base 12.

Figures 3a and 3b show a further stage in the construction of the substructure, in which that substructure is substantially complete. Three further tower portions 15 to 17 have been lifted or jacked into position, and welded out or otherwise secured together on top of each other. The total height of the base 12 and the four tower portions 14 to 17 is slightly less than the water depth in which the completed platform is intended to stand.

In this case, to accelerate the construction programme and to increase flexibility in the fabrication split, the tower is constructed of the four tower portions 14 to 17 in accordance with our U.K. Patent Specification 2282839A. Details of the tower portions and joint configuration may be obtained from that Specification, which is concerned particularly with the introduction of effective batter into a tower by twisting tower portions about a vertical axis. (In the present case all the tower portions 14 to 17 have similar horizontal cross sections, and there is no need for twist to introduce effective batter.)

The 'sail away' of the substructure is shown in Figure 4. The dry dock 10 has been flooded so that the substructure floats, the dock wall has been removed, and tugs 18 and 19 are shown towing the substructure out of the dock and into the open sea, for onward movement to its intended offshore site.

Figures 1 to 4 show one particular method of constructing the substructure. This method comprises the steps of fabricating the base 12 and tower portions 14 to 17 separately, and then assembling these in the dry dock. It will be understood that some of the upper tower portions could be added to the base and lower tower portions when the base had been installed on the seabed at site. This would require a method of assembly similar to that described in our U.K. Patent Specification 2282839A.

Be that as it may, the state of the substructure constructed according to the method of Figures 1 to 4 is shown in Figure 5. This illustrates the base 12 and tower portions 14 to 17 when fully assembled, and prior to installation as a complete substructure - hereinafter designated 21. The complete substructure 21 is floating with its tower (14 to 17) vertical, and

with skirts 22 extending downwardly from the periphery of its base (12). The sea surface is designated 23 and the seabed is designated 24.

In Figure 6 the substructure 21 has been set down on the seabed 24 with its skirts 22 penetrating into the seabed strata. In this condition the top of the substructure 21 is some small distance (7m) below the sea surface.

During construction of the substructure 21 (e.g. as shown in Figures 1 to 3) a light weight deck for the platform has been fabricated concurrently. Fabrication of the deck can take place adjacent to the dry dock 10 for the base 12, or at a different geographic location, depending on the contracting strategy of the operator. The deck 25 shown in Figure 7 has a buoyant hull 26 and four jack-up/jack down legs 27 at or near its corners. In an alternative form (not illustrated) the deck need not have a buoyant hull but would be supported on or between transport barges for its voyage to site. In any case, the deck and 'topsides' would have been pre-commissioned to a very large extent prior to arrival at site.

Figure 7 shows the situation when the deck 25 has arrived in position over the substructure 21, with its legs 27 in a jacked-up configuration.

The legs 27 are then jacked down to engage the top of the substructure 21. Conveniently the lower ends of the legs 27 engage leg ends at the tops of the leg members of the tower portion 17. This situation is illustrated in Figure 8.

When the legs 27 of the deck 25 are firmly connected to the top of the substructure 21, the hull 26 can be jacked up on the legs 27 to a position where its underside is clear of a 100 year design wave. This situation is illustrated in Figure 9.

Figure 10 shows the completed platform comprising deck 25 and substructure 21 with a bridge 28 extending from the platform to an adjacent offshore facility.

The completed platform is shown to a larger scale in Figure 11. In this specific embodiment, the base 12 is 100m square and 20m deep; and the four tower portions 14 to 17 are 25m square and are in total 111m tall. Thus in a particular water depth of 138m, there is a 7m gap between the top of the tower and the sea surface 23. In this case an air gap of 21m is required to clear a 100 year design wave with safety margins, so the unbraced length of the jack-up/jack-down legs is 28m - i.e. 7m below LAT and 21m above LAT.

A contingency against base settlement can be provided by allowing additional leg lengths. The emplacement of gravity platforms in soft soils is not a significant problem, per se, as demonstrated by the successful installation of Statoil's huge Gullfak's C platform on soft soils in 1989. What is significant is achieving, to reasonable tolerances, equal settlement across the base area. Settlement can be controlled by the provision of deep skirts, but excessive skirt height can limit the availability of suitable construction docks. The design shown in Figure 11

should allow a good compromise solution, since settlement uncertainties can be accommodated by providing additional contingency length to the deck legs.

The design shown in Figure 11 comprises a concrete storage base 12 with an integral tower that is economical to build and which is installable with low cost marine equipment. The deck is of jack-up type construction and is installed by the float over method, again achievable with low cost marine equipment.

Emplacement of the deck 25 (comprising hull 26 and legs 27) in the manner described permits a reduced overall schedule, and allows flexibility in the operator's fabrication contracting strategy.

CLAIMS

1. A method of assembling an offshore platform of the kind having a generally flat shallow base to rest on a seabed and a relatively slender tower upstanding from that base to support a deck above the water surface, such method comprising the steps of installing the base and the tower by moving the base and the tower to the site and then sinking them to the seabed so that the tower stands generally vertical, floating the deck over the top of the tower, lowering at least three spaced vertical legs individually from the deck to engage the top of the tower, fixing the lower ends of the legs to the top of the tower, and then jacking the deck up on the legs.

2. A method as claimed in Claim 1 in which the base and the tower are preassembled i.e. joined on shore or at shore before they are moved to the site.

3. A method as claimed in Claim 1 in which the base and the tower are joined offshore prior to the float over of the deck.

4. A method as claimed in Claim 2 or Claim 3 in which the tower is formed from a plurality of tower components stacked one on top of another.

5. A method as claimed in any one of the preceding claims in which the base is formed of concrete.

6. A method as claimed in any one of the preceding claims in which the base has provision for oil storage.

7. A method as claimed in Claim 5 and in Claim 6 as dependant upon Claim 5 in which the concrete base is formed in a floodable area (dry dock) from which the base can be towed out to site.

8. A method as claimed in Claim 7 as dependant on Claim 2 in which the tower is constructed on the base while the base is being formed in the floodable area.

9. A method as claimed in any one of the preceding claims in which the tower is constructed offset from the geometric centre of the base in plan.

10. A method substantially as hereinbefore described with reference to the accompanying drawings.

11. A platform when constructed according to the method of any one of the preceding claims.

12. A platform substantially as hereinbefore described with reference to and as shown in Figure 11 of the accompanying drawings.

The Patent Office

-8-

Application No:	GB 9705934.9	**Examiner:**	Alan Habbijam
Claims searched:	1-12	**Date of search:**	4 June 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): E1H (HB, HCD, HEA, HEB, HEF, HF)

Int Cl (Ed.6): E02B 17/00, 17/02

Other: Online:WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage			Relevant to claims
A	US 5383748	(WADDELL)	see Figs 4&8 in particular.	
A	US4648751	(COLEMAN)	see Figs 7-12.	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.